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Transactions
of the
Mining and Geological Institute of India.

Edited by
The Honorary Treasurer.

Contents:

	PAGE
MEETING AT JHARIA, Held on Monday, April 25th, 1921	85
MEETING AT ASANSOL, Held on Monday, June 20th, 1921	97
MEETING AT JHARIA, Held on Monday, August 1st, 1921	98
Ankylostomiasis: Its cause, Effects and Prevention. By G. W. Thompson, M.B., B.Ch., D.P.H.	99
BHOWRA MEETING, Held on Monday, September 19th, 1921	123

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Transactions
of the
Mining and Geological Institute of India.

Part 2] 1922. [February.

Meeting at Jharia.

Held on Monday, April 25th, 1921.

The first Ordinary General Meeting of the Sixteenth Session of the Mining and Geological Institute of India was held at the Jharia Club on Monday, the 25th April, 1921, at 5-30 p.m.

Present :—Mr. Geo. Miller, President (in the Chair), Messrs. K. K. Baksi, A. Barrowman, B. K. Bose, H. Dave, N. L. Kothari, B. Mitter, H. K. Chatterjee, N. N. Sarcar, N. H. Ojha, H. Cooper, D. A. Anderson, G. Castles, T. C. Murray, F. L. G. Simpson, J. H. Lang, E. Whitehouse, D. Penman, L. Diamond, Jas. A. Oliver, R. R. Simpson, J. E. Phelps and B. Heaton—*Members*.

Messrs Geo. Price, P. Chatterjee and A. Roy—*Visitors*.

The President opened the meeting and introduced for discussion Mr. C. A. John Hendry's paper, "Notes regarding proposed Sand Packing, at Ramnagar." He suggested the discussion might now be closed, which suggestion was accepted.

DISCUSSION ON MR. THOMAS' PAPER, "NOTE ON THE CORRELATION OF THE GANDUDIH, DHERIAJOBA AND WEST GODHUR SEAMS, JHARIA COAL-FIELD."[1]

Mr. R. R. Simpson requested that discussion on this paper be kept open until the author had an opportunity to be present. Mr. Simpson considered that the interpretation of the geology of the area under consideration put forward by Mr. John Kirk was probably correct in the main details, but he, the speaker, had not yet been able to examine the proofs. This paper and the subsequent discussion was very valuable in view of probable inaccuracies of the Jharia Coalfield map lately published.

DISCUSSION ON MR. H. M. TARLTON'S PAPER ON "HYDRAULIC PACKING IN THICK COAL SEAMS."[2]

Mr. F. L. G. Simpson deplored the increasing use of the expression "sand stowing," and felt that to inexperienced minds this term would convey the impression that only sand could be used for this purpose. The expression "hydraulic stowing" is far more suitable and the use of packing material other than sand should not be lost sight of.

The President agreed with Mr. F. L. G. Simpson's remarks and pointed out that Mr. Tarlton used the terms "hydraulic stowing" in his paper.

Mr. J. A. Oliver pointed out that in India hydraulic stowing was in its infancy and most of the members had little experience in this method of mining. He thought the projected visit to either Bhowra or Saltore would help members considerably, and would result in a fuller discussion of Mr. Tarlton's paper. Without hydraulic stowing very large quantities of coal would most certainly be lost in India, and he suggested that a meeting should be held immediately after the projected visit and Mr. Tarlton's paper then discussed.

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[1] Trans., Min. Geol. Inst. Ind., Vol. XV, pp. 68, 139.

[2] Trans., Min. Geol. Inst. Ind., Vol. XV, pp. 107, 142.

Mr. R. R. Simpson said that a visit to Saltore had actually been arranged for September, but unfortunately arrangements fell through. He considered the paper could not be held open indefinitely.

Mr. J. A. Oliver pointed out that after a visit of inspection of actual hydraulic stowing operations a useful discussion of the paper would probably ensue.

Mr. R. R. Simpson enquired if any member was aware of any project in the Assam field of utilising hydraulic stowing.

Mr. J. M. Ritchie said the mine workings in the Assam field were not extensive and consisted chiefly of rise workings, very little yet being done to the dip of the drainage levels. One advantage of hydraulic stowing would be that no underground pumps would be necessary. The water would return to the surface through drainage levels.

Mr. R. R. Simpson explained that seams up to 100 ft. thick lying at an angle up to the vertical cropped out in the hills in Assam, and all workings were arranged above free drainage level by driving in from the valleys, and working all coal to the rise. He considered the conditions very favourable to hydraulic stowing, and the material could be introduced by shoots at the outcrop at the top and sides of the hills, and directed as required underground. Water is plentiful and this would drain freely to the valleys without *cost of pumping.*

Mr. F. L. G. Simpson pointed out that sand would probably be scarce in Assam and suggested it would probably be necessary to quarry and crush rock to provide stowing material.

Mr. R. R. Simpson replying to an enquiry by the President said that the seams in Assam continue to an unknown depth below free drainage level. As yet very little dip working had been done and hence very little pumping. Where pumping was necessary very considerable trouble was experienced with pumps and pipes, owing to the large amount of free acid in the water. The mines were heavily watered.

The President considered the paper should be held open for future discussion.

DISCUSSION ON MR. F. L. G. SIMPSON'S PAPER "PRELIMINARY NOTE ON THE VENTILATION OF INDIAN MINES."[1]

In introducing this paper for discussing the President said that when he first came to India ventilation was a subject that received very little consideration in mining. There were no ventilation problems in those days and natural forces provided all the air necessary underground. A change is rapidly becoming apparent and the introduction of electricity, with the resultant removal of steam plant from the upcast shafts, coupled with deeper and more extensive mining, made it necessary for the mining profession in this country to give greater attention to the subject. There is no doubt natural ventilation methods of the past must give way to mechanical ventilation.

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[1] Trans., Min. Geol. Inst. Ind., Vol. XV, p. 93.

Mr. R. R. Simpson suggested that Mr. Penman, who had lately made some interesting experiments with ventilating fans running in series, might give the Institute some interesting information on this subject.

Mr. D. Penman felt that his experiments on fans in series were on different grounds to the subject matter of the note. In discussing the note he pointed out that the writer had shewn in his figures a wet bulb reading higher than the dry bulb, and enquired if this actually was so. He could quite understand this occurring for short intervals during a period of rapidly falling temperatures in a fully saturated atmosphere, but it was a physical impossibility for a general state of higher wet bulb temperature to exist.

Mr. R. R. Simpson referred members to recent investigations at Home, in which it was proved that 86° wet bulb temperature was the highest a Home miner could work in, and then only for short periods, and pointed out that in Assam he had known of instances where work was carried on in a wet bulb temperature of well over 90°.

Mr. D. Penman pointed out that the velocity of the air has much to do with work in high wet bulb temperatures. Fast flowing air tends to help evaporation of perspiration from the skin.

Mr. F. L. G. Simpson suggested that the acclimatisation of the Indian miner to higher temperatures helps him to withstand higher wet bulb temperatures better than the Home miner.

Mr. H. Brown enquired in view of Mr. F. L. G. Simpson's remarks if surface hygrometrical readings were available.

Mr. F. L. G. Simpson said none were available for the purpose of his note. He considered that generally speaking underground temperatures in India were lower than surface temperatures.

The paper was left open for future discussion.

DISCUSSION ON MR. R. R. SIMPSON'S PAPER, "ACCIDENTS IN INDIAN MINES, AND MINING LEGISLATION."[1]

Mr. F. L. G. Simpson—

1. This is one of the most valuable and interesting papers ever contributed to this Institute, and the facts and figures presented by the author will very much assist in the attainment of the main object of the paper, viz. the prevention of accidents in mines.

2. The leading points brought out by the diagrams given are:—

(*a*) That Great Britain, the leading mining country in the world has been unable to reduce her accident death rate during the past twenty-two years in spite of the advancement of science and the adoption of all the accepted methods of prevention. She has, however, succeeded in keeping the rate practically at the same level over this period except for a slight upward tendency resulting in a total rise of 5 or 6 per cent on the rate per thousand persons employed.

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[1] Trans., Min. Geol. Inst. Ind., Vol. XVI, p 31

(*b*) That India on the contrary has had an increase in her accident death rate per thousand persons employed of about 50 per cent in the same period.

3. The question naturally arises why this great difference should exist? The general examination so far given is that the Indian mines were more in their infancy at the beginning of this period than the British mines, but it should be remembered on the other hand that India had the advantage of British experience and of British leadership at the commencement of this period.

4. Tables and diagrams which take into account *all* the factors in this great question would be welcome if the author with the unique opportunities at his disposal for obtaining the facts and figures could see his way to add them to his contribution.

If he could also add tables and diagrams showing the accident death rate per million tons raised it would be very useful as this is in many ways a better criterion than the rate per thousand persons employed.

5. Tables and diagrams for other mining countries besides Great Britain would also be most useful but we may meanwhile take the British rate as representing the lowest that can be attained so long as the present standard of safety and of preventive methods prevails.

6. Preventive methods are understood of course, to include the adoption of the best and safest methods of working as well as of the best subsidiary measures.

7. The standard of safety depends upon the amount

of risk which is considered admissible, and can best be kept at a proper level by the avoidance of all undue risks.

8. It seems to me that India cannot afford to accept the position shewn in Mr. R. R. Simpson' s tables without statistical proof that it is due to causes over which we have no control that the Indian accident death rate has risen 50 per cent in twenty-three years, instead of keeping on the same general level as it was at the commencement of that period in the same way as the British rate had done. The reason I feel sure is because India has *not* kept pace with Great Britain in the adoption of the best and safest methods of working and general arrangements such as haulage, timbering and other operations and in her standard of safety: also because India has been heavily handicapped in the class of labour available, the proper training of which is a stupendous task.

Serious efforts should be made to prove by statistics what the causes are to which the great rise in the Indian accident death rate has been due and we should no longer be satisfied with mere opinions or statements not supported by proof.

9. I trust the author of the paper will be able to compile these statistics, not only for the benefit of our Institute but for the general good of the country.

Mr. R. R. Simpson did not see how further figures would help matters.

Mr. F. L. G. Simpson said that safety endeavour should keep pace with the mining risks and he thought that further tables and diagrams would bring the chief causes home with greater force and would help the mining profession considerably.

The President said he thought the paper shewed Indian mining in a rather unfavourable light. He pointed out that until the Mines Act was introduced accidents were not reported properly, or in the early days thereof, and this he considered resulted in the figures of the early years shewn in the first diagram being too low. In those days too, Indian mining was very primitive and consisted chiefly of quarries and shallow crop workings; risks were therefore comparatively small.

Mr. F. L. G. Simpson said his point was that the paper gave no real explanation of why, and it is because of this that he asks the author to give further diagrams.

Mr. R. R. Simpson said the paper gives the facts based upon statistics at his command. It was for the profession to explain the why.

The President said that discussion of the whole question was necessary and that causes should be ascertained.

Mr. F. L. G. Simpson suggested that a diagram shewing death rate per million tons raised would be useful.

Mr. D. Penman referred to the author's comments on education and considered education of the workers and sub-officials to the dangers of mining and to the methods of avoiding risks, a considerable power for the reduction of the accident rate. He pointed out that in Britain legislation and education has kept pace with mining difficulties, and instanced the 1911 English Mines Act which required certificates for surveyors and firemen. Mr. Penman considered that with the deepening of Indian mines and the added dangers, the education of the subordinate official to the requirements of the Mines Act and Special Rules was very necessary, and that a full analysis of causes of accidents at Home would prove that legislation and education had kept down the death rate to its present level.

Mr. J. A. Oliver pointed out that shortly all sirdars would be certificated and he considered these officials should be more competent than they are.

Mr. T. C. Murray said he appreciated the points raised by Mr. F. L. G. Simpson and pointed out that the transactions are widely distributed and the paper, which puts Indian mining in a bad light, would be circulated throughout the world. He considered the charts go too far back, as in 1907 there were very few shafts, and coal working was not then dangerous. He suggested the chart should be cut down to cover the period from the introduction of the Special Rules onwards.

The President said that before the introduction of the Mines Act accident data were not reliable.

Mr. F. L. G. Simpson would prefer not to cut down the chart but to explain. He believed this would be far more satisfactory.

Mr. B. Heaton said that funds had been placed at the disposal of the Mining Education Advisory Board to enable them to experiment along the lines of educating the sirdar through his own class: that is, to get the more intelligent and competent sirdar to educate the less competent by explaining conditions of risk and means of overcoming these, and getting him to explain the Act and Special Rules. It is felt that the Sirdars will take more kindly to instructions from their fellows than from men of an outside class.

Mr. A. Barrowman considered that incompetent sirdars are often appointed because of their being able to bring in a number of fresh picks to the mine, and that sirdars' certificates will give better control.

Mr. J. M. Ritchie said that comparisons with other countries are unfair to Indian mining, as the low output rate per person employed necessitates the employment of double the number of persons for a required output. The effect of this was shewn in the death rate per million tons raised of 11·95 compared with that of Great Britain of 5·08.

Mr. R. R. Simpson pointed out that this point is referred to in the paper.

Mr. F. L. G. Simpson speaking of preventive measures pointed out that accidents were best prevented by good methods, and he laid stress upon the necessity of giving proper instructions to subordinate officials concerning proper workmanship. He considered that a reduction in height in working would be a step in the right direction. Side dressing on high ladders was a productive cause of accidents.

Mr. R. R. Simpson said his object in writing the paper was primarily to emphasise the fact that Indian mining was rapidly becoming more dangerous, and that this was proved by the accident rate rising at an alarming rate.

The figures given prove in his mind that fresh legislation is necessary and that the Mines Act should be amended. It was thought that the paper, by shewing the necessity of this, would prepare the minds of the mining profession for the new code which has already been drafted. The necessity for certificates for surveyors and sirdars has been felt for some time, and provision has been made in the new code for this.

The President remarked the paper was most interesting and important and should be kept open for further discussion.

The Discussion on Additional Notes on the Geology of Guzerat by Mr. Edwin Beer was closed.

Meeting at Asansol.

Held on Monday, June 20th, 1921.

The second Ordinary General Meeting of the Sixteenth Session of the Mining and Geological Institute of India, which took the form of a Social Evening, was held at the Asansol Club, Ltd., on Monday, the 20th June, 1921, at 7 p.m. The meeting was well attended by about 80 members with their wives and friends taking part.

A most interesting and instructive lecture was given by Mr. D. Penman, Principal of the School of Mining and Geology at Dhanbad on mine gases and safety apparatus, which was demonstrated by appliances and illustrated by lantern slides. Unfortunately the lecture had to be brought to an abrupt termination through the failure of the lantern.

Supper was served and afterwards a very enjoyable social evening was spent.

Meeting at Jharia.

Held on Monday, August 1st, 1921.

The third Ordinary General Meeting of the Sixteenth Session of the Mining and Geological Institute of India was held at the Jharia Club on Monday, the 1st August, 1921, at 6 p.m.

Present :—Mr. Geo. Miller, President (in the chair), Messrs. D. A. Anderson, J. B. Argyle, R. G. M. Bathgate, W. R. Bell, G. Castles, N. G. Chatterjee, D. P. Davies, L. Diamond, A. Farquhar, Dr. L. L. Fermor, Messrs. B. Heaton, R. Heron, Jhaverial Kalyanray, N. L. Kothari, J. H. Lang, J. Mackie, B. Mitter, J. Murray, T. C. Murray, J. A. Oliver, D. Penman, R. E. Ramsay, J. M. Ritchie, J. Russell, N. N. Sarcar, G. K. Sharma, F. L. G. Simpson, R. R. Simpson, D. D. Thacker, J. Thomas, Dr. G. W. Thompson, Messrs. E. Whitehouse, W. Wightman and J. Wilson—*Members.*

Messrs. R. Aitken, K. N Banerjee, S. K. Banerjee, Captain C. H. Buckingham, Messrs. T. M. Greenshields, Jadulal K. Dholakia, S. Kirk, T. H. Morris, Geo. Perier, C. A. Rayneau, F. D. Richardson, A. Slater, T. A. Wetherell, and W. H. Wilcox—*Visitors.*

The minutes of the first Ordinary General Meeting held at the Jharia Club on the 25th April, 1921, were read and confirmed.

The President expressed the regret of the Council that owing to the difficulty in arranging for a projection lantern, it had been necessary to cancel Mr. Cyril Fox's lecture on "Engineering Geology."

Dr. G. W. Thompson then read his paper entitled "Ankylostomiasis ; its Cause, Effects and Prevention."

Ankylostomiasis: Its Cause, Effects and Prevention.

BY

G. W. Thompson, M.B., B.Ch., D.P.H.,
Medical officer of Health, Jharia Mines Board of Health.

In bringing the subject of ankylostomiasis or hookworm disease to the notice of members of this Institute, my principal object is to point out the extent to which colliery labour is infected with the disease and the importance of taking all reasonable measures to treat the sufferers and to limit infection as far as possible.

Probably all the members know something about the disease, but should there be any to whom it is new, I hope that as a result of reading this paper they will be able to understand the principal details of the disease, while those who already have some knowledge of the subject may benefit by having their recollections refreshed and their interests stimulated.

At a recent meeting of the Indian Mining Federation, in the course of a speech primarily intended to deal with the question of "waggon shortage," one of their leading members made a reference to the Jharia Water Board and to the Mines' Boards of Health at Jharia and Asansol pointing out the burden imposed upon the coal industry by payment of cess to these Boards and then concluded his speech as follows:—

"To boot the hookworm has come, we don't know what this means but we suppose it means more expense."

Under these circumstances of callous indifference it seems desirable that an attempt should be made to sketch in as simple and non-technical language as possible the main facts connected with this disease, which seriously reduces the efficiency of labour employed by colliery owners.

This paper is intended to present the case for treatment and prevention of the disease among the mining communities of Bihar and Bengal.

The scientific name of the disease is ankylostomiasis, a word derived from two Greek words signifying a hook and a mouth. It is known by various other names, as for example, hookworm disease, miner's disease, tunnel disease and Egyptian cholorisis.

In treating the subject of a parasitic disease, the usual sequence is as follows:—

(1) The history of the disease.
(2) The cause of the disease and its life history.
(3) The effects of the disease.
(4) The treatment of the disease.
(5) The prevention of the disease.
(6) General considerations.

THE HISTORY OF THE DISEASE.

The disease is far from being a new one, it is very likely that it was one familiar to the ancient Egyptians, and symptoms probably representing this disease have been found in medical manuscripts dating as far back as 1500 B.C. It is, however, only in recent years that careful investigations have led to a fuller knowledge and a clearer understanding of the disease and of the parasite which causes it.

The first occasion on which the disease attracted public attention in Europe, was at the time of the construction of the St. Gothard tunnel in 1880, when an outbreak of epidemic anaemia occurred among the labourers employed, resulting in many deaths and much incapacity for work. The disease proved to be ankylostomiasis and from this outbreak it received the name of "tunnel disease."

The labourers employed on the St. Gothard tunnel were drawn from many nations of Europe, and when the survivors returned to their own countries they carried the disease with them, and infection became common in Hungary, Belgium and Germany, while, later, the disease appeared in England in a Cornish tin mine in the year 1902, and was proved to have been introduced by labour from the Continent.

There are two kinds of hookworm, the American variety and the Old World variety, but except for a slight difference in their size and structure, they, and the disease which they produce, are identical.

The facts stated above show that ankylostomiasis is a well-recognised disease and for years medical students have been taught the signs, symptoms and treatment of the disease, but in the text books until very recently, the descriptions given were invariably those of a badly infected case.

A few years ago, Rockefeller, the American oil magnate, presented a million dollars for the investigation of this disease and our recent knowledge has been acquired chiefly from work financed by this gift. The most important result of the investigation bears reference to mild infections and may be summed up briefly by stating that there is proof positive, that although such infections may cause apparently no symptom of ill-health, they are almost invariably accompanied by pronounced lassitude and disinclination to work.

THE PARASITE AND ITS LIFE HISTORY.

Let us commence by studying an individual in whose inside there is at least one hookworm of either sex. These live in the bowel and the female lays eggs which are passed with the stools. These eggs are oval in shape, about twice as long as they are broad, and five hundred of them placed end to end will measure, roughly, one inch. In moist soil the egg develops and hatches out a tiny worm about 100th of an inch long and only one one-fifteenth of this in thickness. This develops through various stages in the soil and finally at the end of six to ten days becomes about double the above size, and it is in this stage of existence that it is infective. It can creep up stems, stalks, blades of grass and can get into tiny holes; it can live in water from six to twelve months, and should it come in contact with the naked skin it transfers itself to this and burrows through a hair folicle or a sweat gland into the deeper tissues, thus, it finds its way through the blood stream to the heart, thence to the lungs, through the air passages to the throat and into the mouth, it is then swallowed and passes through the stomach into its final habitat—the bowel. During this process it undergoes development and when it has reached the bowel, it has assumed the characteristics of the adult worm. The whole process only occupies a few days.

In the course of its passage through the skin the worm gives rise to considerable irritation, and the disease known as "ground itch" which is common in the Assam tea gardens and known also as "*pani-ghao*" in Bengal, is almost conclusive evidence of infection by hookworm.

It is practically certain that infection may also be produced by drinking water containing the larvae, though it is not so common in European countries, since the larvae sink to the bottom and are not likely to be taken up unless the water be well stirred.

If the above facts be considered, one important conclusion may be derived, i.e. that the only way in which the number of hookworms in an individual may be increased, is through fresh infection from outside. No multiplication takes place within the bowel, and as the expectation of life of a hookworm is not supposed to exceed two years, it follows, that, provided the risk of new infection be eliminated an infected community will be free from the disease at the end of a certain period.

Let us now proceed to consider the mature hookworm living in the bowel of its host and the results which it produces.

The male has a fan-shaped tail and the name hookworm was originally applied to the worm owing to the fancied resemblance of this tail to a hook. Subsequent study has however shown that the mouth of the hookworm is provided with several sharp teeth by means of which it hooks itself firmly to the bowel. The male adult worm is slightly smaller than the female, which is about three-fifths of an inch in length. The American variety is somewhat smaller in the case of each sex.

The worm attaches itself to the delicate lining membrane of the intestine, a portion of which is drawn into its mouth, and through this it sucks the blood of the host, and clamps on to the mouthful so tightly that the circulation is impeded and the tissues so squeezed die. The worm then leaves a nasty ulcer where it originally was attached and anchors itself to a fresh piece of membrane.

THE EFFECTS OF THE DISEASE.

The symptoms of hookworm disease are ascribed to three causes :—

(1) The loss of the blood sucked by the worm.

(2) The absorption of poisonous substances into the blood of the host through the raw ulcers left by the worm.

(3) The production of certain poisons by the worms themselves, which poisons are set free in the bowel and absorbed into the blood circulation.

Infection does not produce marked symptoms in the majority of cases. To produce severe illness several hundreds of worms must be present at one time; again the longer the period of infection lasts, the worse the result, and further, the degree of resistance to the infection varies in different individuals.

The first symptoms are usually slight disturbances of the digestive system and these are followed by symptoms due to anæmia.

The red corpuscles of the blood derive their colour from a substance called haemoglobin and an adequate supply of this substance is essential to health. Its function is to combine with the oxygen of the air inhaled and to carry this oxygen to the tissues where it yields it up and combines with the carbon-dioxide which it carries back to the lungs and exchanges again for oxygen. The symptoms in hookworm disease are due to the diminution in this haemoglobin, producing anæmia and, later, in more severe cases disturbances of the circulatory system resulting in palpitation, etc., swelling of the eyelids, of the face, of the legs, and, in advanced cases, practically swelling of the whole of the tissues of the body, with a pronounced "pot belly."

In children infection results in an arrest of mental and physical development, thus a child of 12 to 14 years will show a degree of development equal to that of a healthy one of 6 or 8 years, and a young adult of 20 would appear to have developed only to an extent normal in a child of 12 to 14 years. Characteristic symptoms are, a stupid appearance, a bloated face, and eyes which appear to possess a hollow stare.

THE TREATMENT OF THE DISEASE.

Treatment on the whole is extremely satisfactory, but the risk of re-infection is very great. Various drugs have been used and a typical one in its mode of administration is thymol. Thymol is a powerful intestinal antiseptic and acts as a direct poison to many intestinal parasites including hookworms.

The patients selected for treatment are segregated during the evening of the day before. This is an essential precaution, since the ingestion of alcohol before or after the dosage of thymol may lead to fatal consequences.

The patients, on admission, are given a dose of one ounce of Epsom salts, and, on the following morning, after a free action of the bowels, the thymol is administered in two doses with a half-hour interval between.

Each dose consists of 30 grs. of thymol together with 30 grs. of sugar of milk. Two hours after the administration of the second dose another ounce of Epsom salts is administered to the patient and after the bowels have again been freely moved he is permitted to return home. In the stools passed after the second dose of Epsom salts, dead hookworms will be found.

As a rule all hookworms are not expelled in one treatment and it is customary to examine the stools at fortnightly intervals on at least three occasions and to repeat the treatment if eggs are found. The cost of treatment is less than As. 3 per case.

PREVENTIVE MEASURES.

Obviously the problems present three aspects:—

1. The measures to be taken to prevent infection of individuals from infected soil and water.

2. The treatment of infected soil and water so as to render these innocuous.

3. The prevention of fresh infection of soil and water.

To prevent individual infection various measures have been proposed, including the wearing of boots which should be water tight, and the painting of the feet with various substances.

Thus the coolies on one tea garden in Assam before proceeding to their work each morning, were made to walk through a vessel containing tar, and it was noticed that the number of cases of "ground itch" was considerably diminished.

Attempts have been made to treat infected soil with various chemicals which it was hoped would kill the larvae, but up to the present no satisfactory means has been discovered.

It is through measures to prevent fresh infection of the soil that there is most prospect of success. It is obvious that if in a selected area measures were taken to prevent the deposition of any nightsoil containing eggs, that area would become free from infection at the end of the period during which the larvae can exist as larvae, which may be taken as about one year. Obviously the first requirement is the provision of an adequate number of latrines of suitable type and conveniently situated so as to induce the population to adopt their use as far as possible, and provided that every body used them the soil in that area would necessarily be free from infection with the disease at the end of two years at the outside.

Further, all the residents in that area would be free from the disease spontaneously within this period, as the average length of life of a mature hookworm in the bowel is two years. New comers would raise a difficulty, and to maintain the area free from disease it would be necessary to examine all these and in the case of infected individuals to carry out treatment until they were cured.

Apart from these measures a publicity campaign, by distributing pamphlets written in simple language and by lectures illustrated by lantern slides, should be undertaken to spread information as to the nature of the disease and its effect.

General Considerations.

Up to the present we have dealt with the nature of the disease, the method of treatment and the means to be taken for its prevention. We now pass on to the important subject of hookworm infection considered as an economical problem with regard to labour.

The following quotations are from a book entitled "Animal Parasites and Human Disease" by A. C. Chandler, an American zoologist.

"For many years it was customary in the United States to look upon the shiftless people to be found in our South as the product of wanton laziness and an inborn lack of ambition. For decades the more fortunate Northerners considered the "poor whites" of the South a good-for-nothing irresponsible people, worthy only of scorn and of the sordid poverty and ignorance which they brought upon themselves as the fruits of their own shiftlessness. When it became known, largely as the result of investigation by Dr. C. W. Stiles of the U.S. Public Health Service, that these hopeless, incapable and pitifully emaciated and stunted people were the victims, not of their own unwillingness to work or learn, but of the attacks of intestinal worms which sapped their vitality, poisoned their systems, and stunted both their mental and physical growth, and that over two million people in our Southern States were the victims of these parasites the "poor whites" and "lazy niggers" of the South became objects of pity rather than of scorn.

"Dr. McDonald of Queensland, Australia, reports that hookworm 'is sucking the heart's blood of the whole community.' The loss of efficiency of the miners in a single Californian Mine, due to the hookworm, has been estimated at 20%. Estimating only 50% of the miners to be infected, the annual economic loss in this one mine would be 20,000 dollars per year. The economic loss due to the infection of two millions or more people in the South Eastern United States or to the infection of from 60 to 80% of the three hundred million people of India must be almost incalculable."

"The retarding effect of the disease in education and civilization is not less terrible. There are many families in our South where for at least four generations, illiteracy and ignorance have resulted from disablement by hookworm disease. In many communities large proportions of the children are kept out of school on account of physical or mental disablement from this disease. Unlike many diseases, this one has no tendency to weed out the weak and unfit; it works subtly, progressively, undermining the physical and intellectual life of the community, each generation handing down an increased handicap to the next."

The following are instances of the results achieved by treatment of the disease in various places in the New World:—

1. The Managers in the Porto Rico Coffee plantations state, that efficiency of their labour was reduced 35 % to 50 % owing to hookworm disease. This estimate was made after the labour had been systematically treated.

2. In Equador on a cocoa plantation employing 300 labourers owing to the infection with hookworm and chronic malaria, only one-third of their working capacity was obtained.

3. In British Guiana after treatment on a sugar plantation the efficiency of the labour increased 100 %.

In 1915 Colonel Clayton-Lane, I.M.S. carried out an investigation on tea gardens in the Darjeeling District and as a result of an examination of the stools of 10,711 persons 7,211 or 67 % were found to be infected with hookworms.

At a meeting of the Darjeeling Tea Planters Association reported in the press a few days ago, it was stated publicly that the result of an Anti-hookworm Campaign in the gardens had proved so convincing that all the reputable companies were now carrying out treatment at their own expense by means of their own staff.

To come nearer home, an investigation of the labour employed on the collieries within the Jharia coal-field, showed that of 6,045 persons examined, 3,189 or 53 % were found to be infected.

These cases were tabulated into 5,456 employed on collieries and 424 not employed on collieries ; the occupation of the others was not determined. The colliery employees were further subdivided into those working above ground and underground. Out of 2,436 persons employed above ground in collieries 1,207 or 50 % were infected, whilst among 3,020 employed underground 1,756 or 58 % showed infection. Out of 424 non-colliery workers, 169 or 39 % were infected.

The manner of diagnosis adopted, was that of examining the stools for hookworm ova. Obviously a person cannot pass hookworm ova without having hookworms in the bowel, so that the estimate obtained from the above figures cannot show any error in excess, while owing to the fact that for some reason unknown a hookworm ceases at times to lay eggs, it is certain that to some extent the above is an underestimate. Had repeated examinations been made in the case of the negative specimens, the percentage would necessarily have been higher.

It is interesting to note that there is a higher percentage of infection apparent in those working underground. In Europe and countries situated within the Temperate Zone, the hookworm does not have much chance to survive in the soil as it requires a moist climate and a minimum temperature of 50°–60° F. which in such regions is found only in mines. It is for this reason that the disease has been called miner's anæmia. In tropical countries the larvae flourish in the surface soil, and here in India a large percentage of the whole population is infected.

The Jharia Mines Board of Health appointed two Medical Inspectors last year and they were allocated to various collieries primarily to examine the labour for hookworm and to administer treatment. Out of 1,363 infected persons examined by them 253 or 18% received treatment. This result would appear to be very encouraging considering that the only force used was moral suasion and also the ignorance and disinclination of the coolies to accept medical treatment.

The first batch of persons treated were taken from the conservancy gang employed by the Mines Board of Health in Jharia Bazar. Specimens were obtained from every member of this gang and examined for hookworm ova.

On the day following the examination, when the sweepers were mustered, I directed the infected persons to line up by themselves, and the Inspector in charge of the Circle, remarked how extraordinary it was that these persons were the very ones with whom he had trouble and who were continually slacking in their work, and not only had I secured every one of the lazy ones, but I had not included any one of the active ones among them. Since treatment he has reported that he has not had any further trouble with them, and that he at least is convinced their efficiency has considerably increased.

An interesting fact has been brought to light during the course of treatment and that is, the apparent co-relation between hookworm disease, and night-blindness. Among the persons treated at least 30 have complained of night-blindness and in every case where it has been possible to follow up the result, the night-blindness has been cured within two or three days of the administration of thymol. The cure of this troublesome symptom alone is worth much to employers of labour, particularly in industries which work night-shifts.

India has been for ages the home of a plentiful and cheap labour supply, but year by year it is becoming increasingly evident that the coal industry is experiencing a shortage of labour and that the sources from which this labour may be drawn are becoming exhausted. In this connection it is interesting to note that in a community infected with hookworm disease it has been computed that practically a quarter of the pregnancies terminate in abortions or miscarriages, or if the children are born alive they do not survive to adult age. So, not only does the disease detract from the efficiency of the labourers employed but it gradually lessens the number of those who naturally would grow up among colliery environment and who might be expected to take up colliery employment as their profession.

Conditions being so, the problem is how to obtain a maximum output per individual employed and many of the large companies are introducing mechanical coal cutters and other labour-saving devices. There is however another means which should receive attention; this is the adequate provision of suitable means to keep the labour healthy and to cure them as rapidly as possible when they fall ill.

This necessitates as a first measure the provision of an efficient Medical Organization. I do not propose to discuss this subject at length; it is well worthy of a paper to itself; but the present system of permitting individual colliery managers to make arrangements for the treatment of the sick and to engage a doctor for this purpose is obviously unsound. The doctor may or may not possess proper qualifications, may or may not possess any proper skill, in either case the colliery manager is not in a position to judge, as he himself possesses no medical training.

One of the first measures necessary is to place Colliery Medical Practitioners under the control of a Central Medical Organization, to increase their pay and above all to provide them with decent housing accommodation, so as to attract a better class of practitioners.

The returns submitted by collieries within the Jharia coal-field show an average daily labour force of about 75,000 persons. If half of these be infected with hookworm and if such infection results in a reduction of efficiency to the extent of 20%,—and these estimates are very conservative;—this means that 10% of the efficiency of this force is lost or there is no return for the wages of

7,500 persons per day. If the average wage of these persons be taken as annas eight per day, the loss per year in the Jharia coal-field alone works out at more than thirteen lacs of rupees. Surely this state of affairs demands a remedy, and, apart from any question of humanity, the proposition is worthy of support on commercial grounds alone.

Many of the measures introduced and advocated in the more advanced countries of Europe are at present impossible in India, but the provision of adequate and suitable latrines conveniently situated, is undoubtedly practicable, and that the labourers are likely to use these may be deduced from the experiments of the Mines Board of Health.

In Jharia Bazar, three privies, each comprising six seats, have been constructed and were opened to the public in October last. The number of persons using these daily has gradually increased until at present the average number is over 800, and on occasions as many as 1,000 people use them in one day. Caste prejudices do not present the difficulties which were anticipated, and although at the commencement the users were drawn in almost every instance from the lower castes, it is by no means uncommon now to observe a Brahmin entering one of these latrines. Apart altogether from consideration of hookworm disease the introduction of a complete system of latrines and their habitual use diminishes to a great extent the risk of infection in the case of all the communicable intestinal diseases. In a country where cholera, dysentery and enteric fever are rampant, the importance of such provision should be self-evident.

The facts recorded in this paper are stated without exaggeration and care has been taken to reject anything that has not been proved beyond reasonable doubt. Having brought these facts to the notice of those interested in the coal industry in India, it remains for them to decide whether existing conditions are to be allowed to continue indefinitely, or whether a determined and combined effort is not to be made to reap the benefit of experience obtained elsewhere and to attempt to set a period to a state of affairs for which there is no excuse.

DISCUSSION.

The President said that the paper was a most interesting and valuable one.

There was every reason to believe that Dr. Thompson's figures were borne out by real facts since they were the result of very recent investigation. It was therefore urgently necessary that such facts as he had brought to our notice through the medium of his paper should become known to all those concerned in the industry. The efficiency of the Mining labour was being very seriously impaired through this disease and may have a very important bearing on the very inefficient work and low production of the Indian miner.

It appears to be a subject that is deserving of even closer and more complete investigation and Dr. Thompson's paper certainly discloses a condition of things to which remedial measures should be applied without delay.

The paper besides being of great value from a health point of view, is also of great commercial value in suggesting remedies for a disease involving serious financial loss to the Companies.

It is not a paper that we can feel competent to criticise being a highly technical medical work, but I am sure Dr. Thompson would be pleased to answer any questions regarding it which any member may desire to ask. I would further suggest that this paper be circulated to the press and copies sent to such Calcutta agents as are interested in mining. Such information as this paper contains, cannot be too widely known.

I hope Dr. Thompson will again favour us with another paper, perhaps on malaria or cholera, two of the visitations that are always with us.

Dr. L. L. Fermor proposed a hearty vote of thanks and stated that the subject deserved careful attention.

Mr. J. Mackie seconded the vote of thanks.

Mr. R. R. Simpson expressed his appreciation of the paper, and stated that some sixteen years ago he had made enquiries as to the prevalence of ankylostomiasis in the Jharia and Raniganj coal-fields. He was informed that the disease was unknown, and the reason given for its absence was the non-prevalence of malaria and the consequent ability of the population to resist infection. It seems more probable, however, that the disease had escaped diagnosis. Ankylostomiasis is a tropical disease and has been endemic in India since time immemorial. In Assam coal mines and in gold mines in various parts of India it has long been recognised, and due precautions against it have been taken. At the Singareni collieries in Hyderabad (Deccan) most of the members of the large European staff have suffered from it from time to time. They have been instructed to wash their hands thoroughly before partaking of food, and as a rule such precaution is sufficient. The disease is probably more prevalent in metal mines than in coal mines, and this because persons have to place their hands on the rungs of ladders soiled by the feet.

Dr. Thompson had given the percentages of surface and underground workers affected as 50 and 58, respectively, in Jharia coal mines. It would appear, therefore, that a colliery was a favourable breeding ground for the parasite. He suggested that labourers should be induced to wear shoes. It would be one way of spending their increased wages. The practice of wearing shoes is undoubtedly on the increase. He remembered the time when the ordinary chaprasi or syce went barefooted. Such men nowadays almost invariably wear shoes.

Dr. Thompson had referred to latrines on the surface only, but Dr. Tomb, Chief Sanitary Officer, Asansol Mines Board of Health, had informed him that he intends to submit to his Board proposals for the provision of underground latrines in mines in the Raniganj coal-field. In the draft code of rules for metal mines in the Northern Shan States, Burma, provision has been made for underground latrines of sanitary pattern. In metal mines in other parts of India underground latrines have been provided for many years.

Dr. Thompson in replying to Mr. R. R. Simpson, said that as recently as 1917, at a meeting attended by Dr. Bentley, Major Ross, Dr. Tomb, and himself, Dr. Bentley had suggested the prevalence of hookworm in the coal-fields, but the others considered that there was very little, if any, prevalence of the diseases. This was due to the fact that advanced cases of the disease are rarely seen in the coal-field and that the importance of the effects of the disease in mild cases and the work done on this subject had not at that time become common property.

Mr. R. R. Simpson was anxious to know if the

Institute could do anything to help Dr. Thompson in combating the disease.

With reference to a design for privies underground, the work of designing suitable ones did not present great difficulty, but it was doubtful whether the colliery labour would use them if provided, since privacy can usually be obtained readily in underground workings. Such a latrine should not require attention more than once a year, and possibly only once in two years, and therefore practically did away with sweepers.

Dr. Thompson said that Mr. Simpson was incorrect in his statement of percentages. The degree of infection was 39 % among villagers, 50 % among colliery employees working above ground, and 58 % among underground workers. The probable explanation of the increased degree of infection among colliery employees is that it is due to congestion of the labour resulting in a higher degree of infection of the surface soil.

Mr. J. M. Ritchie asked Dr. Thompson whether proportion of cases of ankylostomiasis found in persons employed underground compared to those employed on the surface at the mines was attributable to the higher temperature and more humid condition of the atmosphere underground such as obtained in the Assam mines.

His experience and information there was that the disease was almost wholly found in underground workers including Europeans and that a fully saturated atmosphere of not less than 80°F was essential to the existence of the hookworm.

In reply to Mr. Richie, *Dr. Thompson* pointed out that there was not much difference in the percentage of infection among above-ground and underground workers, and that atmospheric conditions above ground did not in India prevent the development of the larva. In Europe, the surface temperature is too low for the larvae to develop and the disease is confined to underground workers.

Further, in western Europe the use of closets is almost universal and as a result the soil does not become infected to any degree. A temperature of 80°F was beneficial to the larvae and hastened their development more than a lower degree.

With regard to the higher percentage of Europeans affected by it in Assam, he pointed out that in mines with step faces the use of ladders permitted infection through the skin of the hands and under such circumstances the use of boots would not provide a safeguard to the same degree as elsewhere.

Mr. F. L. G. Simpson stated that the figures given in the paper regarding the financial loss caused by the disease must come as a shock to most people, and asked how this loss compared with that caused by other diseases?

With reference to the remarks of Mr. F. L. G. Simpson, *Dr. Thompson* pointed out that the difficulty lay in obtaining reliable statistics. The colliery Dr. Babus were in many instances too careless or ignorant to record cases of death with proper accuracy. For example, 90 % of all deaths are reported as due to fever, which is not in any way the cause of death, but is merely a symptom of many diseases. He could, however, show the fatal number of deaths from each cause as stated by the Dr. Babu, but this would not include colliery labourers who left the colliery to die elsewhere.

Mr. F. L. G. Simpson asked if this was going to be the end of the matter.

Dr. Thompson replied that the total number of deaths could be given irrespective of cause, but it is difficult to record the people who went home to die. Hookworm and malaria could be recorded.

Mr. R. R. Simpson communicated the following, being an extract from the *Colliery Guardian* of 5th August, 1921 :—

A series of papers has appeared in the Indian *Journal* of Medical Research, examining the therapeutic value of various chemical anthelmintics in connection with the hookworm enquiry in the Madras Presidency. (Rev. Father Prof. J. F. Caius, and Dr. K. S. Mhaskar, M.D.) Most of the results are negative.

The investigators, however, confirm the conclusion already arrived at by others that chloroform mixed with castor oil is a universal worm remedy of great importance. The advantages of chloroform are the following : Combined with castor oil, it requires no special preparation of the patient ; it can be administered at a single dose ; it does not cause local or general disturbances, either immediately or subsequently ; and it is perfectly well tolerated and not nauseous.

Chloroform is decidedly effective as an anthelmintic against hookworms, and is particularly potent against ankylostoma. Chloroform, treatment, however, necessitates hospital conditions.

In a paper on "The Prevalence of Ankylostomiasis in the Madras-Presidency," Dr. Mhaskar records investigations in the Trichinopoly Jail showing that freedom from hookworm infection seems to diminish the susceptibility to bowel complaints. They also show that the average death rate and the average period of illness from bowel complaints are likewise lessened. The figures also show that freedom from hookworm infection seems to diminish the susceptibility to influenza infection.

Another paper on "Hookworm Infection and Sanitation," by the same author, supports the conclusion that mere improvement in sanitary conditions without the help of any specific treatment is sufficient to bring down the intensity of hookworm infection. Under sanitary conditions, natural elimination alone, without the assistance of any specific treatment, appreciably lowers the intensity of the infection, but natural elimination is a slow process, and the success of an anti-hookworm campaign will depend on the concomitant actions of sanitation and specific treatment.

At 8 p.m. members partook of refreshments provided at the Club and enjoyed the remainder of the evening in music and dancing.

DISCUSSION ON MR. J. THOMAS' PAPER, "NOTE ON THE CORRELATION OF THE GANDUDIH, DHARIAJOBA, AND WEST GODHUR SEAMS, JHARIA COAL-FIELD."[1]

In reply to the discussion on this paper Mr. Thomas writes as follows :—

I regret that owing to my being out of the country from May 1920, until January 1921, I was unable to be present at the meetings of the Institute to read the paper and take part in the geological excursion and subsequent discussions.

I therefore take this opportunity of thanking Mr. R. R. Simpson for the great interest he has shown in the subject under discussion and also Mr. J. Kirk for the labour he has taken in preparing a larger and more detailed plan and for the arrangements regarding the borehole put down in Godhur, north of the District Board Road showing the coal there to be No. 11 seam and not No. 10, which is being worked on the south side on practically the same horizon, and thus proving the extension of the Dhariajoba fault to the east.

Mr. R. R. Simpson states that my correlation of the seams is based entirely on similarity of the sections and points out the unreliability of such methods. With the latter I agree. Correlation based on similarity alone is of doubtful value and often misleading. In comparing sections their distances apart must be taken into consideration as lithological changes are sure to occur, the magnitude of the change increasing with the distance. This is especially so in the case of the thick seams of the Jharia coal-field with their high ash content and numerous partings, all of which point to a lacustrine origin. Rocks formed in shallow or still waters are irregular in thickness and composition, often changing rapidly from thick coarse gravels to thinner sands and clays. These facts were borne in mind when examining the geology of this locality.

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[1] Trans., Min. Geol. Inst, Ind., Vol. XV, pp. 68, 139; Vol. XVI, p, 86.

A rapid change in thickness is shown to occur in the stratum separating Nos. 11 and 12 seams, from Alkusa to Ekra (vide p. 69, Vol. XV). It has also been shown that great differences in the sections of the strata occur in No. 1 Incline Dhariajoba (vide Sketch p. 70 and third para. p. 71) within 40 feet of one another. These differences cannot be explained as lithological changes. The disturbed zone between the sections also indicates faulting. The similarity also of the sections on the north of the fault to the characters of Nos. 11 and 12 seams, within a limited region, and of those on the south to that of No. 10 seam, also show the fault to be a large one.

I heartily endorse Mr. Simpson's recommendations to the younger members of the Institute, to study the local geology. Managers also should not be content to prove just the bottom of a seam by a bore-hole or trial shaft. The boring should go beyond. Cases are known where an inferior seam has been worked for years, whereas a superior one lay only a few feet below.

DISCUSSION ON MR. R. R. SIMPSON'S PAPER ON "ACCIDENTS IN INDIAN MINES, AND MINING LEGISLATION."[1]

Mr. R. R. Simpson was prepared to admit that the low output of the Indian coal miner inflated the fatal accident rate per million tons of coal raised. In the paper, however, he had laid no stress on these figures, but based his case on the rate per person employed. The figures given showed without doubt that accidents were becoming more numerous. The paper was designed to show that more stringent regulations appear to be required.

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[1] Trans., Min. Geol. Inst. Ind., Vol. XVI, pp. 31, 90.

Bhowra Meeting.

Held on Monday, September 19th, 1921.

The fourth Ordinary General Meeting of the Mining and Geological Institute of India was held on Monday, the 19th September, 1921. Over a hundred members visited the Bhowra Collieries of the Eastern Coal Co., Ld., Jharia Coal-field, on September 19.

The visitors met at the house of the Superintendent, Mr. J. Mackie, at 8 a.m. and from there a number of small parties were arranged, each under the guidance of a member of the company's staff.

A number of most interesting features of modern mining were witnessed. Bhowra stands on the left bank of the Damuda river, and is therefore ideally situated regarding the supply of river sand. In order to extract the largest possible quantity of coal and to reduce the danger of underground fires the company has been experimenting for the last two years in hydraulic stowing. An aerial ropeway crosses the river to the right bank at Amlabad, and from here large volumes of sand are conveyed daily to No. 8 incline, where No. 14 seam is being worked. The seam is 40 ft. thick in this locality and in the deep workings it is almost flat. It is by no means therefore an easy proposition to stow this thick seam. The sand is tipped into a hopper at the surface and thus passes on to the mixer where it is mixed with water, the proportions ranging from 1 of sand to 2 or 3 of water. This mixture then flows in pipes to the workings, filling up the goaf areas and thus enabling the whole of the seam to be extracted without danger of fire or subsidence of the overlying strata.

The aerial ropeway is 1,250 yds. long and has a capacity of 40 tons of sand per hour. An excavator of the elevator bucket type raises the sand from the river and loads it into the tubs which run alongside. The sand is then conveyed to the loading bunkers from which the aerial ropeway buckets are filled.

At Amlabad, on the south of the river, the visitors witnessed the operation of the cement gun. This is used for shooting liquid cement by means of air pressure on to walls, thus forming a layer ranging from a mere film up to several inches in thickness. The cement coating thus formed is known as gunite. At Amlabad gunite is used to line the shaft walls, thus preventing the weathering of the weak shales, and protecting the brick lining in the upper part of the shaft. There appears to be a great field in mining for this ingenious device for the protection of roadways, building underground engine houses, and sealing off fires, etc.

Mr. T. L. Clarke, Cement Gun Representative in India has kindly supplied the following account of the Cement Gun:—

"The basic idea of the cement gun was conceived by Carle E. Akeley a big game hunter and naturalist who at present time is conducting an expedition in Africa. Mr. Akeley in building large mounts for big game, was continually working with gypsum with its quick setting properties and he saw the need for the introduction of water into the material at the moment of placing in its final position.

As the result of his experiments a chambered nozzle was produced, which allowed the dry material to be blown, by means of compressed air, through a film of water near the point where it left the nozzle. This accomplished the desired effect of hydration at the moment of placing and it also allowed the discharge of cement plaster through a hose at high velocity. This latter was a problem which had puzzled engineers for years, as any attempt to send wet plaster through a hose had resulted in clogging of the hose and ruinous delays in operation.

The gun itself is a double chambered tank with air locks between the chambers, to allow re-charging of the machine without stopping the operation. The lower chamber contains a device which controls the quantity of material passing into the hose. This device is known as the feed wheel. It is a cast iron cone with pockets in the periphery of its base. It is mounted on a vertical shaft which is driven by an air motor through a worm and pinion, thus causing the feed wheel to rotate, bringing the pockets of material in front of the outlet hose through which it is blown by the compressed air.

The sand and cement plaster, placed by means of the gun, is known as "gunite" and differs from the usual sand and cement product in that all the initial " set" of the cement is retained and that the plaster is placed under pressure. A third point of interest is that, in this method, only the correct amount of water of hydration is introduced since any excess will be squeezed out by the pressure applied, and any under hydration will cause "puffing" and "dusting" of the material which will immediately be noticed by the operator.

As a result, or rather as a by-product of this method of placing, we have:—

A. Great density

B. High tensile & compressive strength.
C. Exceptional bonding properties.

These points are of practical value to the engineer in the following ways:—

A. (1) High water-proofing qualities.
(2) Resistance to deteriorating actions such as acids, salts and corrosive gases.
B. (1) Permits reduction of sections on all construction, thus lightening total loads and effecting savings in material.
C. (1) Eliminates bad joints between old work and new. It has been definitely proved that the joint between old concrete and gunite is stronger than the concrete.
(2) Permits a permanent application to brick walls, rock surfaces and to steel.

The usual application of gunite contains three parts sand to one part cement although mixtures of from 2½ to 1 to 6 to 1 have been used successfully. The sand need not be of special quality but it is desirable to have a well-graded sand running from fine up to that which will pass a ¼″ mesh screen.

Tests made on a 3 to 1 mixture of gunite by various departments of the United States Government and several Universities in America have given figures which may be taken as authoritative:—

Ultimate compressive strength	4,000 lbs. per sq. inch.
Modulus of Elasticity	4,705,000 lbs.
Absorption (water) after 28 days set	4·5 %

Another test of interest was made by the University of California to determine the degree of imperviousness. A sample of gunite 1″ thick was subjected to a head of water equivalent to 1,610 feet for two hours with no indication of seepage through the sample. The head was then gradually raised to 3,400 feet, when failure took place due to leakage a little before breaking.

One of the most important steps in the history of the cement gun occurred in 1911. When the Chief Engineer of the Government Bureau of Mines in the United States, Dr. Geo. S. Rice, procured a machine to work out a theory of his own at the Government Experimental Coal Mine at Brucetown, Pa. Dr. Rice advanced the theory that the majority of falls in coal mines were caused entirely by the action of moisture in the atmosphere and that penetration of this moisture caused the lime in the rock to slack allowing falls to take place of anything from mere pebbles to sections of 25 or 30 tons. Timbering which was used to hold up a roof thus weakened did not stop the action and weathering went on working back into the strata for unknown distances. Dr. Rice felt that the solution of the problem lay in covering the sections subject to weather with a thin coat of cement. His experiments with cement paint failed through flaking off of the paint and he turned to the cement gun, which allowed him to put on a thicker protective coating and also provided a better bond to the rock surface.

After this coating had stood for several years and had been tested by explosions, it was examined by a number of mining engineers, who were satisfied that this thin coating of cement was a positive protection against weathering and that it fulfilled all the other requirements of mining conditions. Several mines immediately adopted the cement gun and proceeded along the lines laid down by Dr. Rice. Subsequent experiments show that ½ to ¾ of an inch of gunite is the most economical and effective working thickness to prevent weathering.

Since that time the development of the cement gun in mine work has been rapid and has extended throughout the coal-fields and into the metal mines, one company alone, the Anaconda Company, having at present 30 cement guns operating in their holdings.

Some of the uses to which mine operators have put the gun are enumerated below :—

Shaft lining.
Lining of underground roadways roof-side.
Building brattices.
Sealing off fires.
Fireproofing timber lagging.
Building underground pump houses.
Constructing sumps.
Rust-proofing steel shafts.

At the recent luncheon given by the Eastern Coal Co. to the Mining and Geological Institute at the Jharia Club, Mr. George Miller, the President of the Institute, in his remarks on the exhibition of mining equipment that had been witnessed during the morning at the Eastern Coal Companies property at Bhowra spoke very highly of the use Mr. Mackie was making of the cement gun at Amlabad, stating that in deep shafts where a brick lining was used, there was great danger of falling bricks owing to the poor quality of country bricks, and consequently he considered that it was a very sound policy to put this thin coating of gunite over the brick surface to prevent weathering and disintegration. Mr. Miller spoke further on the suitability of gunite for preserving underground pillars, where weathering caused the sides of the pillar to disintegrate and fall off, until they were no longer capable of supporting the roof. He also mentioned as a further field of usefulness in Indian mines the lining of road ways and the sealing off of mine fires.

Users of the cement gun in the Indian mines at present are:—

Eastern Coal Co., Jharia Coal-field.
Mysore Gold Mining Co., Kolar Gold-fields, South India.
Burma Mines Ltd., Northern Shan States, Burma.

A partial list of English mining companies who are using the gun includes:—

Pelaw Main Colliery.
Manvers Main Colliery.
Powell Duffryn Steam Coal Company.
Fife Coal Company.
Cowpen Coal Company.

With the increasing use of compressed air in the Indian Mines, the cement gun will doubtless become a universal piece of mining machinery here as it has in England and America."

Having witnessed a practical demonstration of the gun, the party were kindly supplied with light refreshments by Mrs. Mackie. The party then proceeded to the site of the New Coking Plant and Power House. Two batteries of 25 Semet-Solvay Waste-heat type coke ovens are being constructed.

The ovens will be supplied with slack coal from a reinforced concrete bunker (built by the Reinforced Concrete Engineering Co., Ltd.), which will be 112 feet high and capable of storing 1,000 tons of coal.

The coke will be discharged by a ram and forced out through a coke quencher into a twin coke car, which is run up by means of an electrically operated main and tail haulage, to the top of the screens. The waste heat from the ovens will be fed to Babcock and Wilcox boilers.

The coking plant will include tar extractors and sulphate of ammonia plant and sulphuric acid plant.

The acid plant has been designed by Messrs. Waldie & Co., Konnagar. The power station will include four Babcock and Wilcox water-tube boilers, and will generate steam at 200 lbs. per square inch. Each boiler will be fitted with a chain grate stoker, and gas burners, so that coal or gas may be burnt according to the circumstances.

The generating plant will be composed of two 1,000 kilowatt Metropolitan Vickers turbo-alternators, generating current at 3,300 volts.

At Amlabad the winding will be done electrically. Current will be transmitted from the power house at Bhowra to the Amlabad sub-station at a pressure of 11,000 volts.

The whole of the plant reflects great credit upon the Company, and their Superintendent, Mr. Mackie.

An excellent lunch was provided by the Eastern Coal Co., Ld., at the Jharia Club. The arrangements for the lunch were well carried out by Mr. S. Ollar, Honorary Secretary of the Jharia Club. Mr. G. Miller, the President, stated in his speech that this has been one of the most interesting excursions of the Institute, and it is to be hoped that the benefit to be derived from such visits will be realised by the younger members of the mining profession.

A hearty vote of thanks was passed to Mr. and Mrs. Mackie and the Eastern Coal Co., Ld.

The following description of the plant kindly furnished by Mr. Mackie was handed to members present:—

AMLABAD.

Here 3 shafts are being sunk as follows :—

No. 1 to a depth of 450 ft.
Nos. 2 & 3 to a depth of 1,400 ft.

All plants at present in use, with the exception of No. 1 Pit 50 ft. headgear, is temporary and will be replaced within the next twelve months as under :—

At No. 1 Pit, a 90 H.P. electric winder will be fitted.
At Nos. 2 & 3 Pits, 2–210 H.P. electric winders with 9′6″ to 14′6″ semi-conical drums will be erected.
Nos. 2 & 3 headgears will be 57 ft. high and of lattice type.
The Sentinel Air Compressor and the Ventilating fan will be replaced by motor-driven gear and all shaft pumps will be electric.
No steam plant will be used.

"Meco" rock drills are in use in the shafts. In shale three drills can cut 15 holes each 7 feet deep in two hours while in very hard rock the same number takes five hours to drill.

Ventilation is obtained from a 30-inch "Sirocco" fan, through 15″ pipes producing about 2,000 cub. ft. per minute per shaft.

The shafts are 18 ft. diameter and at present it is hoped to protect the sides by "gunite." This is a coating of cement and sand of $\frac{1}{2}$″ and upwards in thickness and is sufficient to stop all weathering of the rocks. In the case of the weaker shales, reinforcement of chicken wire will be added.

The "gunite" is applied by a "cement gun," a demonstration of which was given.

If large feeders of water are encountered, it is the intention to introduce the "cementation" process of sinking.

HYDRAULIC STOWING.

This method of working was introduced early in 1919 at Bhowra to assist in the recovery of the largest possible percentage of 14 seam and to prevent the occurrence of underground fire.

At present work is proceeding in two districts of No. 8 Incline where the seam is 40 ft. thick :—

(1) in a district where the seam was originally mined in two sections and the bottom section is now being extracted and stowed.

(2) in a district where the galleries were driven to the full thickness of the seam.

In No. 1 district the seam is practically flat which makes stowing difficult.

The total vertical head from the mixer on the surface to the goaf is 140 ft.

The total length of piping is—1,430 ft.

Total number of bends in route—10.

Sizes of pipes—6″ reduced to 4″.

Gradient of pipes—1 in 4, 1 in 25, almost level.

Proportions of sand and water used :—

(1) With long lead and many bends—
1 sand 3 water.

(2) With shorter lead and fewer bends—
1 sand 2 water.

AERIAL ROPEWAY.

Length of line—1,250 yards.

Difference in altitude—27 yds. against loads.

Capacity of ropeway—40 tons of sand per hour.

Capacity of buckets—8 c. ft. or 8 cwts.

Number of buckets per hour—100.

Speed of rope—160 yds.

Power required—28 B.H.P.

Bunker of 60 tons capacity with 3 shoots at loading point.

Hopper of 90 tons capacity with shoot and operating lever at unloading station :—

Diam. of rope—$1\frac{1}{16}''$.

River span—146 ft.

Highest trestle—118 ft.

SAND EXCAVATOR MANUFACTURED BY HENRY BERRY, LEEDS.

The excavator was purchased to load sand in the river bed and save coolie labour.

It is of the elevator bucket type excavating on one side of truck and delivering spoil down a shute on other side into tubs alongside. It is at present driven by a compound engine, but will be driven by a motor later.

It is capable of dealing with one ton of sand per minute.

Beyond a trial run, the excavator has not been used yet owing to want of power when dealing with wet heavy sand, and owing to floods upsetting the track.

BY-PRODUCT COKE PLANT.

Hoppers, elevators.—Two under-rail hoppers will receive the slack from the collieries. The first will feed the main elevator which supplies crushed slack to the bunker. An elevator from the second hopper will deliver to two disintegrators of the Carr type with countershafting and motors, the crushed coal to fall into the main elevator hopper. Coal breakers for breaking up lump coal whenever necessary, will also be driven from this countershaft.

Coal service bunker.—The reinforced concrete bunker (built by Messrs. Reinforced Concrete Engineering Co., Ld., Calcutta) will be 112 feet high and will have a capacity of 1,000 tons of coal: it is situated midway between the two batteries of ovens, hoppered at the bottom and fitted with siding gates, deck for charging larry, etc.

Charging larry.—This will be electrically operated and will travel along the top of the ovens, dropping the coal into same through the charging holes.

Ovens.—There will be two batteries, each of 25 Semet-Solvay waste-heat type, designed by Messrs. The Coke Oven Construction Co., Ld. of Sheffield. Each oven will be 33 ft. long, face to face, by 20″ wide by 8 feet high, with a capacity of 9½ tons of coal.

Ramming and levelling machine.—The racking and travelling motions are operated from a 40-H.P. motor. On this machine there will be a crane jib with gearing and motor for lifting the oven doors on the ram side.

Main flue and chimney.—The waste-heat flue is led to the front of the Babcock and Wilcox boilers and connected to a brick chimney 9 feet diam. by 180 feet high.

Discharge hearth.—Consists of a line of cast iron plates along the length of the battery, carried on concrete walls, and on the plates is a track for carrying the quencher car.

Coke car.—The coke will be discharged from the ovens into a twin coke car which will run on a track along the discharge side of the ovens.

Coke car haulage and screens.—An electrically operated main and tail haulage, with sheaves, etc., will move the car up an incline to the top of the screens, with stocking room for coke on a bench and along side the haulage incline.

Gas exhausters.—Two steam-driven Bryan-Donkin rotary exhausters (each large enough to deal with the gas from 50 ovens) one to be kept as standbye.

Tar recovery plant.—Will include Reutter-type condensers for cooling the gas from the ovens, and Hunt's tar extractors.

Sulphate of ammonia plant.—This will consist of two "direct recovery" saturators, and one ammonia still; liming tank; lime mixer and pump; acid and mother liquor tanks; ammoniacal liquor feed tank and liquor heating apparatus; drier for ammonia vapours; salt ejectors, air compressors, centrifugal dryer for salt, with motor and conveyor to deliver salt to store.

Pump house.—Motor driven centrifugal pumps will deliver the water required for the condensers and for quenching coke. Belt-driven Lee Howl pumps will deal with the tar and ammoniacal liquor.

A sulphuric acid plant.—consisting of horizontal chambers and necessary sulphur burners, etc., to design of Messrs. Waldie & Co., Konnagar, will be built on the east side of the coke plant, where all sulphuric acid required for the manufacture of ammonium sulphate will be made. The buildings are all being roofed in ferro-concrete. The sulphate house, sulphate store, and exhauster house will be built by the Indian Patent Stone Co., Ld., and the power house, haulage house and pump house by the Reinforced Concrete Engineering Co., Ld.

POWER STATION EQUIPMENT.

Boiler plant.—Four Babcock & Wilcox water-tube boilers of 4, 510 sq. feet heating surface, for steam at 200 lbs per sq. inch and super-heated to 150°F. All fitted with chaingrate stokers, gas burners and necessary ducts for waste heat from coke ovens: Green's economisers. Lee Howl feed pumps.

Generating plant.—Two 1000 kilowatt 7 P.F. turbo sets of Metropolitan-Vickers manufacture running at 3,000 R.P.M. and capable of 25 % overload for two hours.

Current will be generated at 3 phase, 50 periods and 3,300 volts. For transmission to Amlabad, it will be stepped up to 11,000 volts. The condensers are of the Lee Blanc multiple-jet pattern. No water-cooling device or softening plant will be provided; 180,000 gallons per hour of Damuda water is being arranged to supply the needs of the coke plant boilers and condensers.

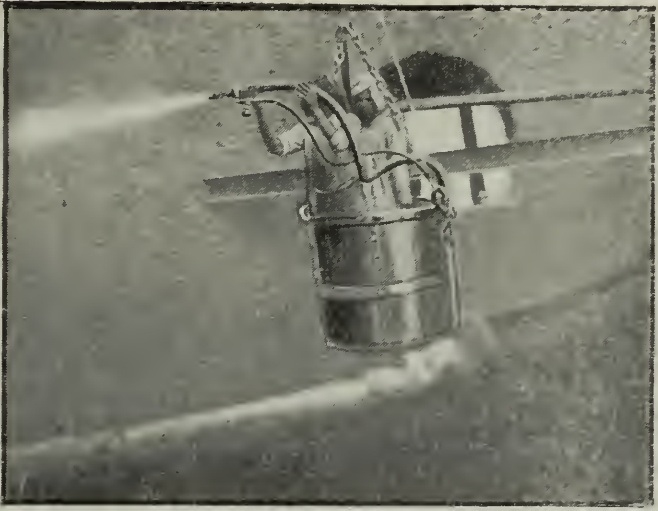
A 2,000 K.W. set will be added later.

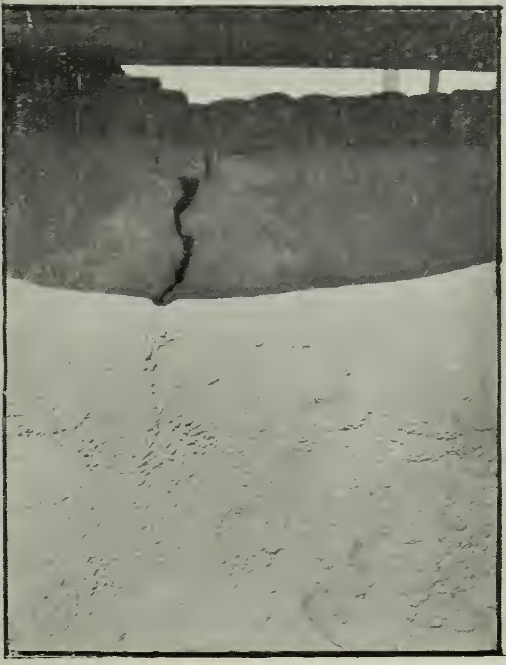
Main switchboard.—This will consist of 15 panels sheet steel, cubicle type, absolutely self-contained and provided with fool-proof interlocks.

The coke oven distribution board, the 1,1000 volt control panel and the several oxide film lightning arresters will be erected in the switchboard gallery, while various transformers will be coupled up in the basement.

The boiler plant will be housed at some distance from the power house, which is 60 ft. by 60 ft. by 42 ft. high, and provided with a ferro-concrete roof.

* * *





1. Bucket.
2. Brick Lined Shaft.
3. Rock Cut.

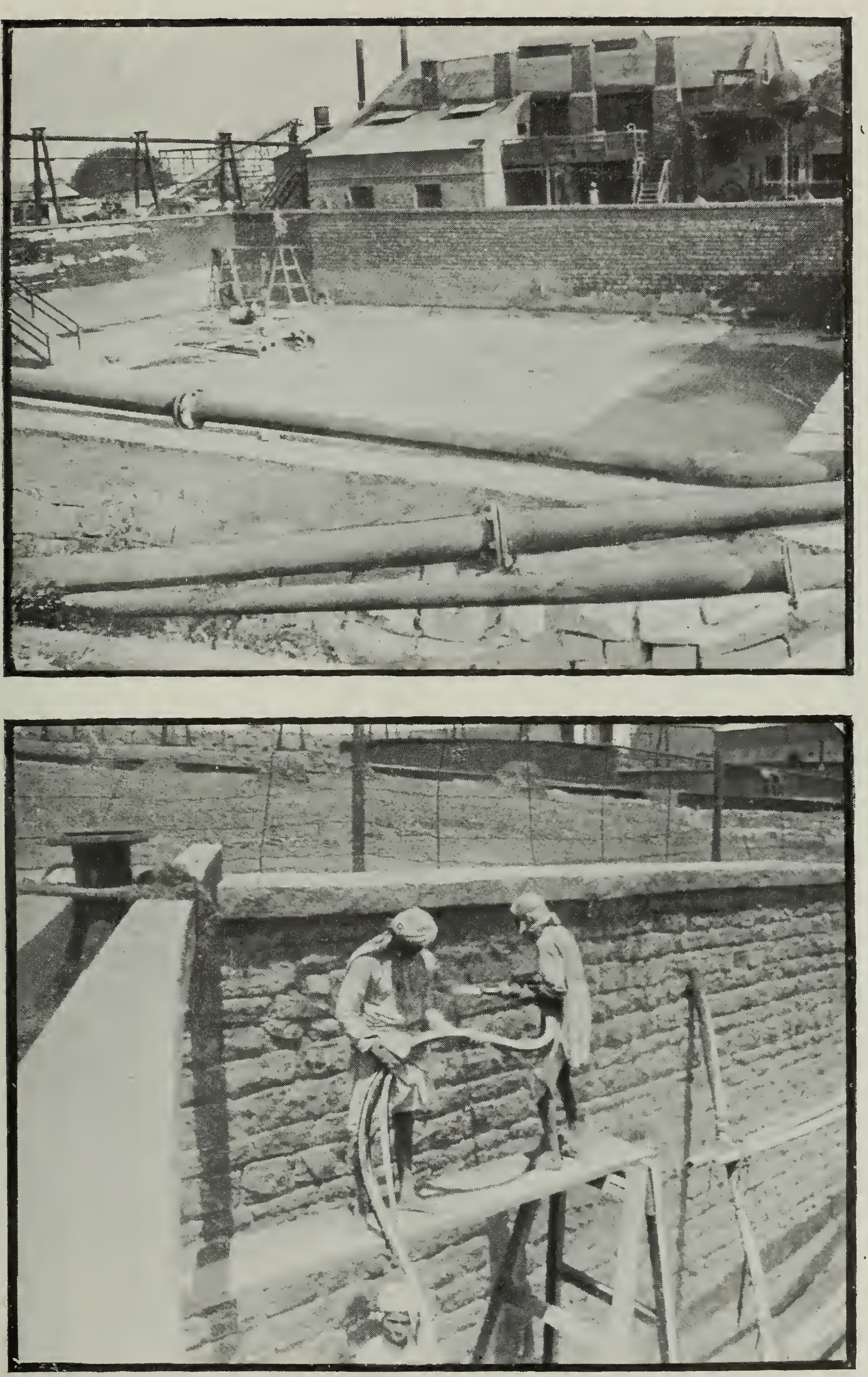
In the Coal-fields.

No. 1. Shaft, Amlabad, Jherria Field.

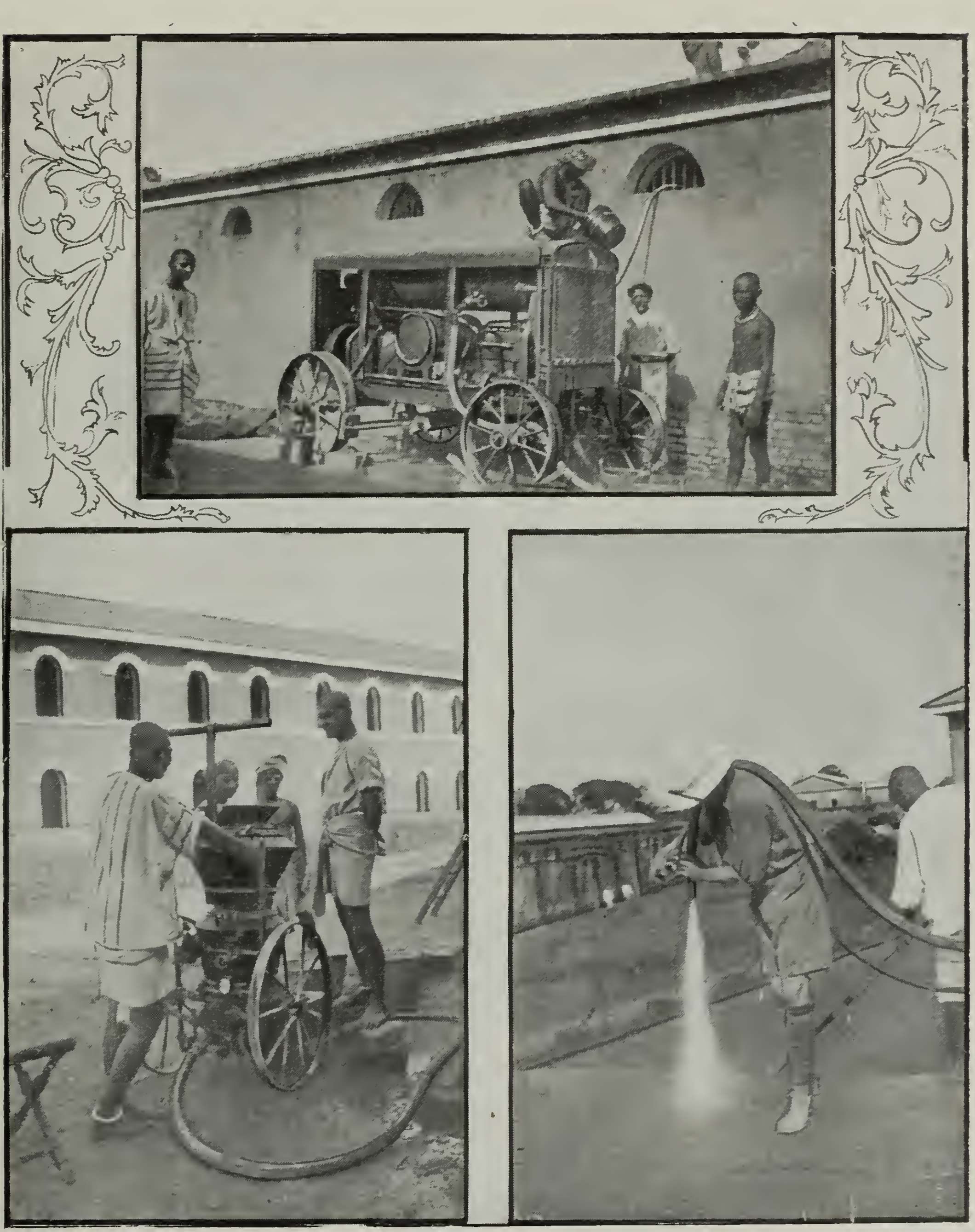
The Brick lining was gunited to prevent disintegration and falling of bricks. The rock cutting below the Brick lining was covered with ½ inch to ¾ inch of Gunite to stop the weather action and shaling of rock.

Three fourths of an inch of Gunite will stop weathering and do away with Timbering except where squeeze or earth movement occurs.

The Cement Gun is also used for sealing off fires, for closing discarded air passages, and for building underground pump houses.

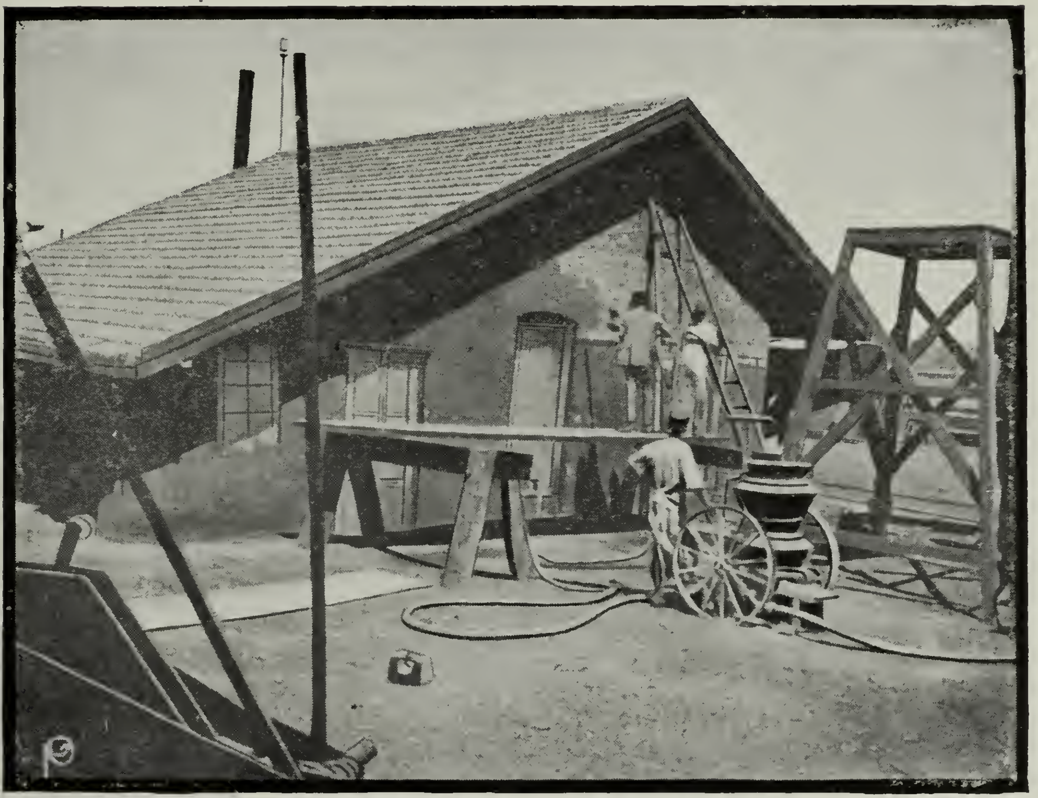


Water-proofing a Masonry Cyanide Tank at the
Mysore Company's Mine by filling the interstices with "Gunite."



Water-proofing a Roof in the Rangoon Jail.

This work was done by the Public Works Department of Burma with an N-O Cement Gun and Ingersoll-Rand Type XIV Petrol Driven Portable Compressor (shown in cut).



G.I.P. Railway.

Making a Puckka Building out of a Rough Masonry Compressor house. This building is now being considered for office purposes.

They are now using the gun to coat steel bridges to protect them from rust and the effects of Locomotive Blasts.

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